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THE PHYSICAL GEOGRAPHY OF THE SOUTHERN PART OF THE MALAY PENINSULA*

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The term "Malay Peninsula" covers the portion of Asia that forms a continuation of the region where Burma and Siam meet. Unfortunately the term is not precise; the southern end of the Peninsula is clearly defined; on the other hand a difference of opinion exists as to where the Peninsula ends and the Isthmus of Kra begins, both latitude 10° N. and latitude 13° N. having been given recently as the northern limit. The land with which we are concerned in this paper is almost the same as "British Malaya" and comprises the land between latitude 1° 7′ N. and latitude 7° N. In this area there is some Siamese territory to the north-northeast; the remainder, with adjacent islands, is made up of the Straits Settlements (Penang, Province Wellesley, the Dindings, Malacca, and Singapore), the Federated Malay States (Perak, Selangor, Negri Sembilan, and Pahang), and the Protected States (Perlis, Kedah, Kelantan, Trengganu, and Johore).

CLIMATE OF THE PENINSULA

Situated in the warm seas of the tropics and remote enough from the volcanic arc of Sumatra and Java to be untroubled by eruptions and earthquakes, untouched also by the devastation of typhoons, the Malay Peninsula is one of the most favored corners of the world. The rainfall is heavy, varying from about 80 inches to 160 inches per annum, according to the position of the recording station with regard to the mountains, and is distributed fairly equally throughout the year. It is often claimed that seasons can be recognized; but a study of statistics convinces me that, south of Kedah at any rate, the only division of seasons is that once put forward by a wit who remarked that one might recognize a "wet" and a "wetter" season. September, October, and November are generally wetter than the rest of the year; but it does not often rain before noon in any month. There is an abundance of sunshine, and sometimes dry spells of a fortnight or so occur. In Kedah and northwards wet and dry seasons are recognizable.

The heat is not great. The average daily maximum shade temperature is 88° F., and I believe that 100° F. in the shade has never been recorded.

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* I am indebted to Mr. C. Boden Kloss, Acting Director of Museums, F. M. S., for suggestions in connection with this paper and for the loan of photographs of Gunong Tahan.

The nights are cool enough for comfortable sleep. But, while the actual thermometer readings are low compared with those in some other countries, the daily maxima and minima vary little throughout the year, and the air is laden with moisture. There is no cold season. On the low ground the thermometer occasionally drops below 70° F. at night; at an altitude of 7,160 feet I have seen it drop to 54°; but after much experience in various stations I think that a range of 70° to 88° F. throughout the year expresses the general shade temperature of the country, including the night.

On the east coast the northeast monsoon blows fairly strongly between November and March; on the west the force of the southwest monsoon is broken by Sumatra. Generally speaking, day breaks on a perfectly still atmosphere; then a light breeze springs up and may increase to a stiff breeze later. Squalls occur sometimes that do local damage.

The Soil, Vegetation, and Scenery

The warm, moist climate has attacked the surface rocks and formed soils that support a luxuriant vegetation. Before man made clearings nearly the whole country was covered with jungle dense enough to shut out a view of anything beyond a hundred yards. Big game hunters state that in virgin jungle forty yards is the usual range at which they get a shot. The abundant rainfall, however, has created a network of rivers where one can see nature at the height of tropical beauty. No artist has yet done full justice to our Malayan rivers, flanked by giant trees of varied hues of green, gray, and brown; sometimes meeting overhead to form a shady avenue along which one can drift downstream for miles; now tumbling over rapids, now flowing peacefully through Malay villages to the beautiful east coast with its sandy beaches, bright sunshine, and fringe of *Casuarinas*—beaches that contrast favorably with the muddy, crocodile-infested mangrove swamps of the west coast, where sandy beaches are not so easy to find. On some of the highest peaks of the mountain ranges the vegetation thins sufficiently to enable one to enjoy to the full, without cutting down trees, an extensive view of billowing, jungle-covered country; and on the highlands below the summit of Tahan (7,188 feet) one can walk over open spaces at about 5,000 feet where a very poor soil and the northeast monsoon have checked the growth of everything but low scrub (see Figs. 6 and 7).

In addition to fertile soils, the Peninsula has mineral wealth. Few lands have been so well endowed by nature; but on the other side of the account we find tropical diseases, the gradual sapping of energy by the constant moist heat, and numerous flying and crawling things that bite and sting. Nevertheless, many persons manage to live here, with occasional holidays in a cold climate, for the greater part of their working lives; few, if any, escape being infected with malaria; but nowadays deaths from it among white people are rare.

BIOGEOGRAPHICAL INDICATIONS OF LAND MOVEMENTS IN THE PENINSULA

Before describing the present configuration of the Peninsula I will sketch very briefly the opinions generally held by biologists concerning the effect of land movements in the Peninsula and Archipelago relative to sea level, as indicated by the distribution of fauna and flora.

This area was the scene of Dr. Alfred Russel Wallace's classic work, and to him we are chiefly indebted for the elucidation of the problems of distribution.

In 1896 Mr. R. Lydekker quoted Dr. Wallace's views accepting his conclusion as "on the whole, a very probable explanation of the facts of the case."[1] Without entering into the biological evidence, Dr. Wallace's opinion was as follows:

> [In Miocene times] Java would have been at least three thousand feet lower than it is now, and such a depression would probably extend to considerable parts of Sumatra and Borneo, so as to reduce them all to a few small islands. At some later period a gradual elevation occurred which ultimately united the whole of the islands with the continent. . . Java was then separated by subsidence. . . A little later the subsidence may have extended farther north, isolating Borneo and Sumatra, but probably leaving the Malay Peninsula as a ridge between them as far as the islands of Banca and Biliton. Other slight changes of climate followed, when a further subsidence separated these last-named islands from the Malay Peninsula[2] . . .

More recent work has thrown further light on this subject. Thus Mr. H. C. Robinson says:

> It is therefore, I think, fairly evident that at some comparatively recent time a barrier has existed between the mountains of Southern Selangor and their continuation in Negri Sembilan, sufficient to prevent the extension of the dominant continental and Sumatran forms southwards. It is evident, also, that this barrier must have been a substantial one, as wide stretches of low country separating the Gunong Tahan Ranges from the backbone of the Peninsula have not sufficed to effect any specific differentiation in the fauna of the two ranges.[3]

Again, Mr. H. N. Ridley in 1916 wrote, concerning the flora of Kedah Peak, that it resembled that of Mt. Ophir,

> especially in the occurrence of lowland seashore plants, isolated as they are from the ordinary habitats of these plants by the forest that lies between them and the sea. . . There can be little doubt that Mount Ophir was at one time an island detached from the mainland as Penang is to this day, and it seems highly probable that Kedah Peak may have been similarly isolated.[4]

More recently Mr. C. Boden Kloss writes:

> The northern limit of the true Malaysian flora, which covers the southern half of the Malay Peninsula, Sumatra, Borneo and—to a less extent—Java, and of which the conti-

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[1] R. Lydekker: A Geographical History of Mammals, Cambridge, 1896, pp. 302, 303.

[2] A. R. Wallace: Island Life, New York, 1881, pp. 353–354.

[3] H. C. Robinson: A List of a Small Collection of Mammals and Birds from the Mountains of Ulu Langat, Selangor, *Journ. Federated Malay States Museums*, Vol. 4, 1909–11, pp. 235–241; reference on p. 241. Kuala Lumpur.

[4] *Ibid.*, Vol. 7, 1916, p. 37.

> nental section may be called Malayan, seems to be a line joining the towns of Alor Star (in Kedah) and Singgora (at the entrance to the Inland Sea).
>
> Botanical features confirm what geological investigations indicate—that this boundary was the coast line of what was once an island but what has since become the southern half of the Malay Peninsula.[5]
>
> I would call this Alor Star-Singgora line a major transverse break in the Malay Peninsula and am inclined to think that there is another between Bandon and Pangnga, and perhaps Bandon and Trang.

These opinions indicate that the "further subsidence" mentioned by Wallace as separating Banka and Billiton from the Peninsula, may have gone farther than was necessary to produce the present configuration. I am convinced that was so and that the subsidence continued sufficiently to reduce the southern part, at any rate, of the Peninsula to a group of islands, that is part of the Archipelago. We know from raised beaches that there has been a very recent elevatory movement. I will give my reasons later for considering the final movements were (1) subsidence, reducing the Peninsula to a group of islands; (2) elevation, probably continuing today, that brought the Peninsula to its present condition.

Summarizing this period of land movements then, we have:

1. The elevation of a group of small islands scattered over a wide area, on the present site of the Archipelago and Peninsula, to form part of the mainland of Asia.
2. The separation of Java by subsidence.
3. The separation of Borneo and Sumatra by subsidence.
4. The separation of Banka and Billiton from the Peninsula.
5. Submergence of a large part of, if not all, the Peninsula to form a group of islands.
6. Elevation of these islands to re-form the Peninsula.

COULISSES

The Malay Peninsula is but a small part of a large region that is thus described by Suess:

> In this way the mighty swell of the Altaides in Thibet subsides and is dispersed. The whole continent becomes lower. Many coulisses disappear. Only a few long branches are continued: on the east into the cordillera of Annam; on the west, always giving rise to fresh coulisses, through the Malay Peninsula, and still further, to Java and beyond.
>
> We have now arrived at one of the most instructive parts of the earth's surface. Four elements combine to form it: the end of the Burman arc, the southern branches of the virgation of the Philippines, the spurs of the great cordillera of New Guinea, and finally the continent of Australia, with the cordillera which marks its eastern border and crosses Torres Strait.[6]

The word "coulisse" here means prominent features arranged *en échelon* on the earth's surface like the wings of the stage in a theatre. Such features are formed by folding of the stratified rocks and the intrusion of masses of igneous rocks, followed by erosion.

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[5] *Ibid.*, Vol. 10, Part II, 1920, p. 79.

[6] Eduard Suess: The Face of the Earth, Engl. transl., Oxford, 1908; reference in Vol. 3, pp. 231–232.

Suess describes a granite coulisse as becoming the Lakawn Range, entering the Peninsula and thence onwards representing its axis. This description was based on material collected when little was known of the Peninsula; and one object of this paper is to show how the Lakawn, or Nakawn, Range is succeeded by several other coulisses *en échelon*, which together form the skeleton of the Peninsula as defined above, and to trace the probable continuations of these coulisses into the Archipelago where they join coulisses described recently by Mr. Van Es.[7]

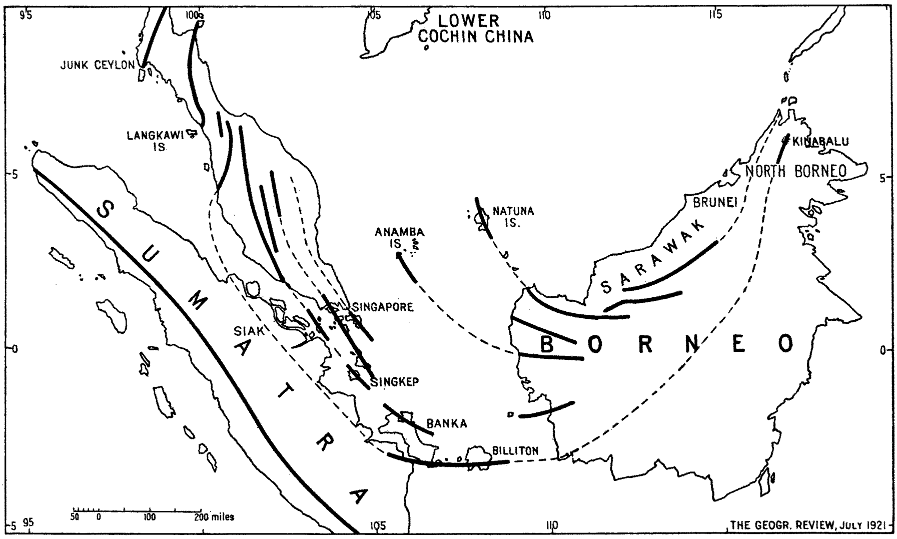

FIG. 1—Sketch map showing the probable connection of "coulisses" in the Malay Peninsula and Archipelago.

Nakawn Coulisse

The maps, Figures 2 and 3, show in some detail the main features of British Malaya, but before discussing them I would refer to the smaller map, Figure 1 on p. 355, for a moment. In the part of the continent north of the Langkawi Islands two coulisses are marked, the westerly one ending near Junk Ceylon, the easterly being, in the central portion at any rate, the Nakawn Range, which Suess described as entering the Peninsula and representing its axis. Field work in Perlis has given me some knowledge of the southern part of this coulisse, and I have good reason for believing that its true course is as represented; that is, on reaching Perlis, it bends slightly to the west of south and reaches the sea near the Langkawi Islands.

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[7] L. J. C. Van Es: De tektoniek van de westelijke helft van den Oost-Indischen Archipel, *Jaarboek van het Mijnwezen in Nederl. Oost-Indië*, Vol. 46, Part II, 1917, pp. 5–143. The Hague.

Turning to Figure 2 we see the termination of this coulisse on a larger scale (No. 1). It forms the boundary between Perlis and Setul. In the north of Perlis granite occurs in it, but elsewhere this boundary range consists of rugged limestone hills, which one finds again on the east coast of Langkawi Island, the center of the island being granite. I have climbed hills on and near the northern border of Perlis between coulisses 1 and 2

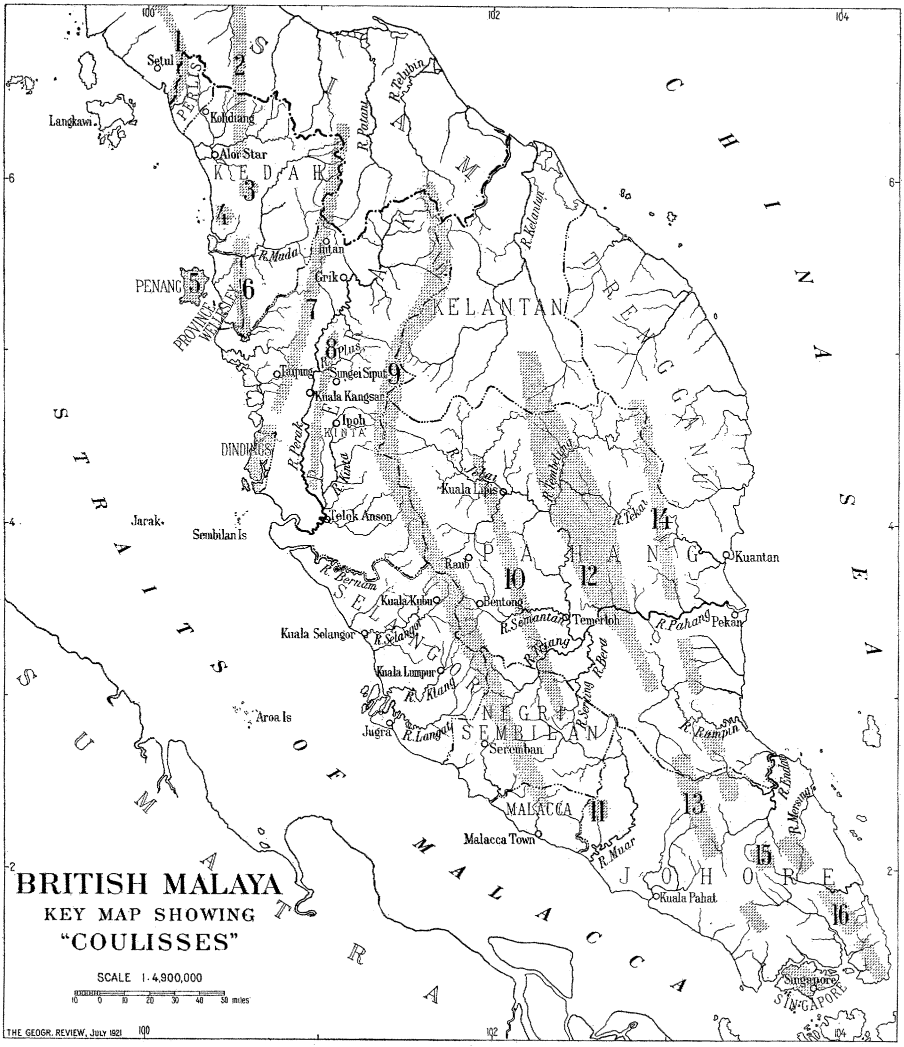

FIG. 2—Key map of British Malaya showing coulisses. The coulisses are represented diagrammatically by bands of shading. They are not in every case continuous mountain ranges (compare Fig. 3 opposite). References to numbers are: (1) Nakawn Coulisse, (2) Kedah-Singgora Coulisse, (3) Gunong Perak, (4) Kedak Peak, (5) Penang, (6) Granite hills of Province Wellesley, (7) Bintang Coulisse, (8) Kledang Coulisse, (9) Kerbau Coulisse, (10) Benom Coulisse, (11) Mt. Ophir, (12, 13) Tahan Coulisse, (14, 16) East Coast Coulisse, (15) Blumut Range.

to search for any continuation of this Nakawn Range into the Malay States to the southeast; but, although it should be plainly visible, I could not see one. Through the supposed site of it a railway has been constructed without difficulty, not to mention an earth road; while the watershed between Perlis and the Siamese territory to the north is for a large part only about 300 feet high. My own observations are corroborated by others who have been farther into Siamese territory than I have. There can be no question that the Nakawn Range does not enter the Peninsula as its

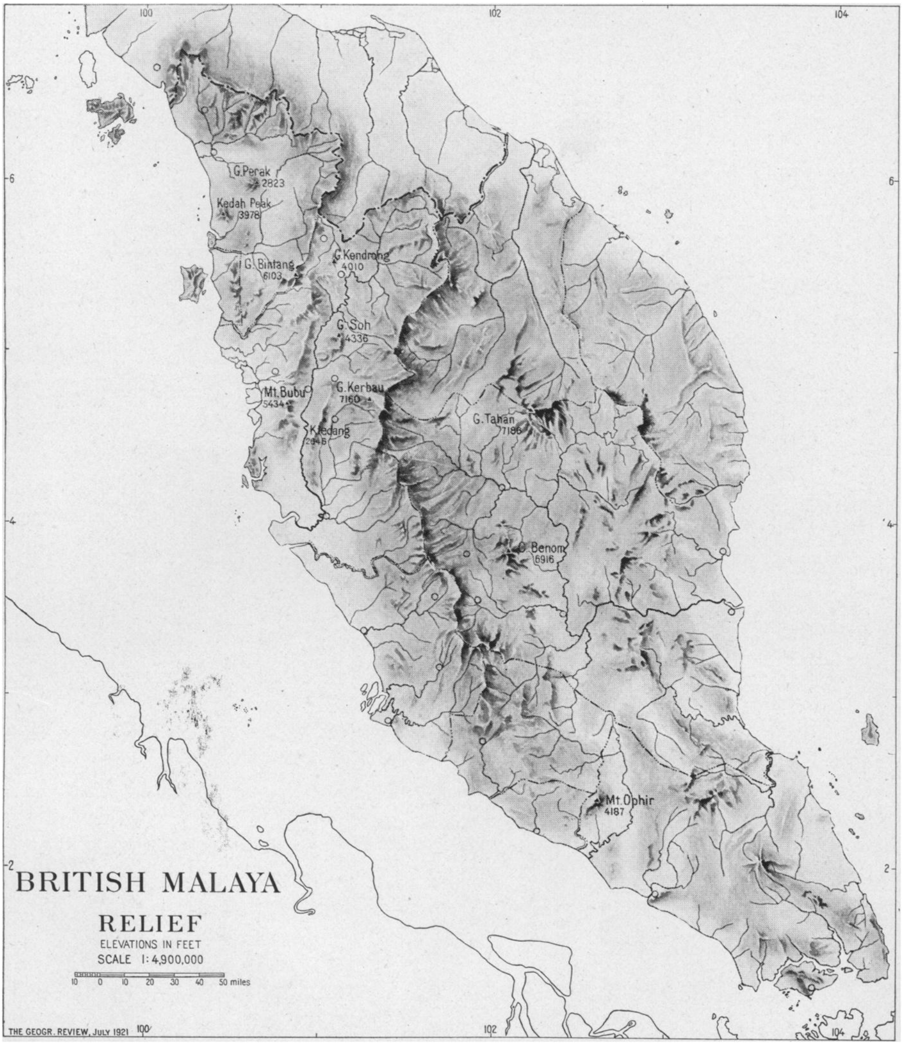

FIG. 3—Relief map of British Malaya based on the F. M. S. Government Survey Map of 1913. For locations and river names see the map opposite, Figure 2.

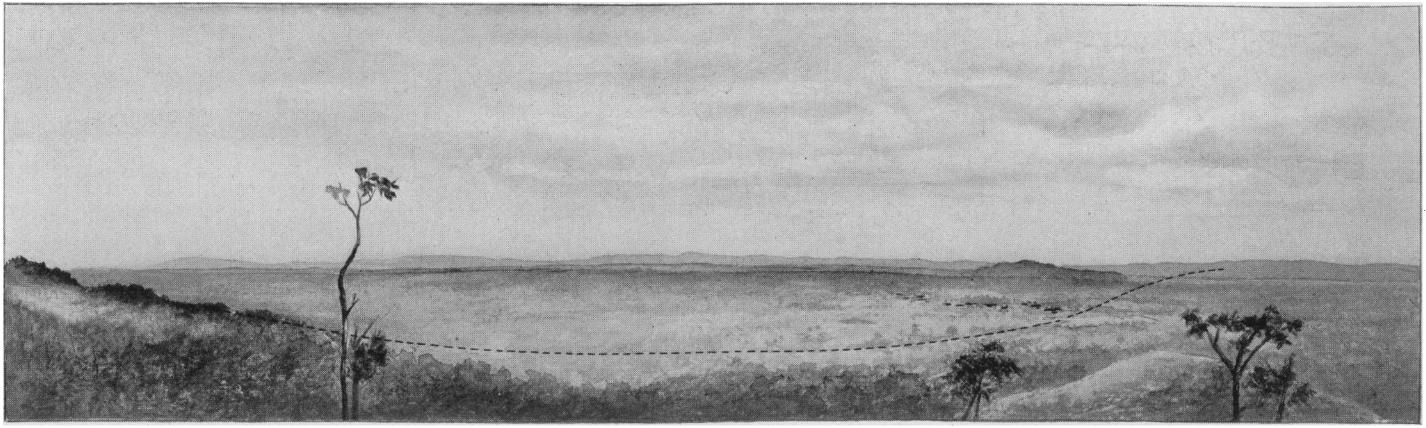

FIG. 4

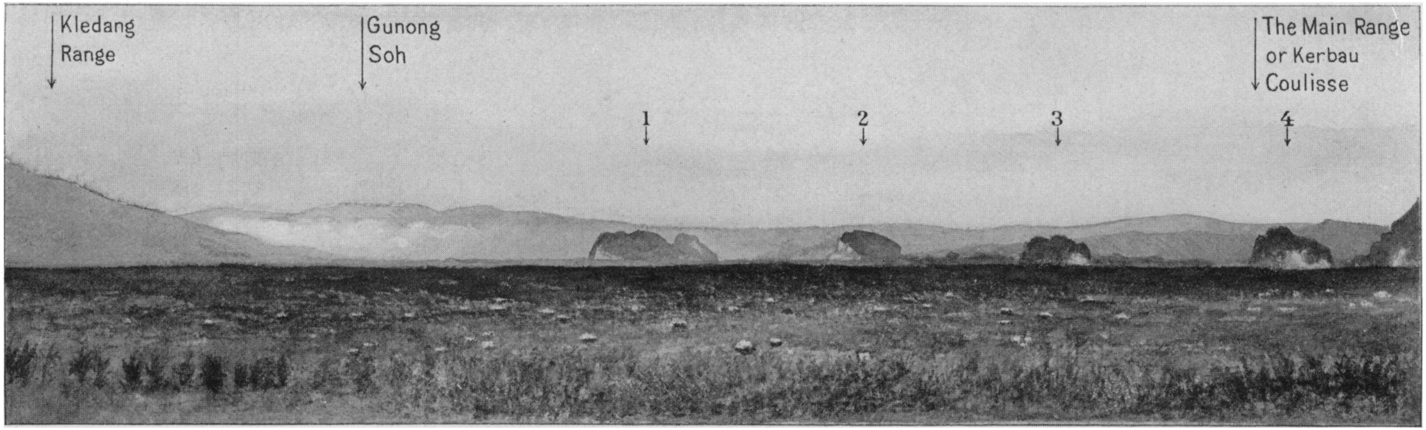
Kledang Range
Gunong Soh
1
2
3
4
The Main Range or Kerbau Coulisse

FIG. 5

FIG. 4—Sketch from a photograph, looking eastward, showing the low watershed between the state of Perlis and Siamese territory. The dotted line indicate the approximate position of the watershed. Padang Besar, a railway station on the border is seen in the middle distance. The range of hills in the far distance is the Kedah-Singgora Coulisse.

FIG. 5—Sketch from a photograph, looking north, showing the low watershed between the Plus and Kinta Rivers. The Plus flows from the distant hills on the right through the cloud-filled gap between the Kledang Range and Gunong Soh. The Kinta River flows through the gap between limestone hills 2 and 3 towards the left of the sketch.

axis, but the statement that it does so will die hard and will probably be quoted for many years to come among those who do not know the ground.

KEDAH-SINGGORA COULISSE

The land between the end of the Nakawn Coulisse and the Kedah-Singgora Coulisse (2) is low-lying. In Perlis and Kedah it is extensively cultivated for paddy, and from the broad stretches of the rice fields isolated limestone hills rise abruptly. In Perlis these limestone hills form a double chain stretching through the center of the state, the first being about eleven miles inland from the present coast. Other limestone hills are found in Kedah, at Kohdiang, and near Alor Star where Elephant Hill is a well-known feature in the landscape.

The Kedah-Singgora Coulisse is formed of hills rising above 2,000 feet and composed chiefly of quartzite and shale. At least one granite outcrop is known. Almost due south of its southern termination is an isolated mountain (3), Gunong Perak; and to the southwest of this again is Kedah Peak (4), or Gunong Jerai, another isolated mountain, 3,978 feet high and composed of quartzite with granitic intrusions. On the eastern border of Province Wellesley are small granite hills (6). Penang Island (5) also is granite.

BINTANG COULISSE

East of the Kedah-Singgora Range the boundary of Kedah and Siamese territory is hilly, but the peaks are highest where the border turns sharply southwards. Their composition is unknown to me; but southwards and across the headwaters of the Muda River they are continued as the first large and purely granite range in British Malaya (7). It contains two fine peaks, Bintang (6,103 feet) and Bubu (5,434 feet). I propose to call this the Bintang Coulisse. South of Taiping these granite hills break down for a space and then reappear in the Dindings and Pulau Sembilan (Nine Islands). West of Pulau Sembilan is another granite island, Jarak, which I have recently visited. East of the Bintang Coulisse is the Perak River valley in British territory and, in Siamese territory, the River Patani. The watershed between these rivers close to the Bintang Coulisse is only a little over 1,000 feet. Grik, close to the Perak River, is only 380 feet above mean sea level, but the country through which the river flows until it reaches Kuala Kangsar is all hilly and affords some of the finest tropical scenery imaginable. The hills are of quartzite and limestone lying on a granite platform, but close to the river is a well-marked granite range (8), cut through by the Plus north of Sungei Siput, in which the best-known peak is Kledang near Ipoh (2,846 feet). The highest, however, is Gunong Soh (4,336 feet) north of the Plus. The granite of this range is covered by quartzite in the southern part.

KERBAU COULISSE

To the east of the Perak River is the Main Range (9), or Kerbau Coulisse (Gunong Kerbau, 7,160 feet), formed of granite with some sedimentary rocks high up among the granite hills. This range is the most striking feature of the Peninsula and has five peaks over 7,000 feet grouped near the Kelantan-Pahang border. The mountains decrease in height as one follows them south until they die away in Malacca.

Although I have been nearly to the headwaters of the Perak, I know very little of the northern end of this range. From a hill at Intan, north of Grik, I have looked down the broad Patani valley and can only say that the Main Range must end somewhere between the Patani and Telubin Rivers in Siamese territory.

Between the Main Range and the Kledang Coulisse (8), the watershed between the Plus and Kinta Rivers is very low (271 feet). To the south of Ipoh rolling country merges into an extensive alluvial flat extending along the coast as far as Negri Sembilan, from which rise here and there little hills of quartzite and granite. Nearer the Main Range is an extensive belt of low quartzite hills not indicated on Figure 1.

BENOM COULISSE

To the east of the Main Range, which is distinctly ex-centric in its position, lies the greater but less developed part of British Malaya. Two metalled roads, from Kuala Kubu and Kuala Lumpur, enable one to travel easily over the Main Range into Pahang. Flanking the granite hills on the east is a much lower range of quartzite foothills near Raub and Bentong, and east again of these is a belt of comparatively low-lying country, composed chiefly of calcareous rocks, which terminates abruptly against the Benom Coulisse (10) in which Benom is the only high mountain (6,916 feet), situated between the Jelai and Semantan Rivers. This coulisse also is granitic but rich in hornblende. Northwards its continuation is marked by inconspicuous granite outcrops. To the south the Semantan cuts through rocks found in the Benom massif, while there are further outcrops extending into Negri Sembilan. Mt. Ophir (11), 4,187 feet high, may be a prolongation of the Benom granite, and the same may be true of granite hills near Kuala Pahat; but the separation of these outcrops from the Kerbau Coulisse in Negri Sembilan and Malacca is open to question.

TAHAN AND EAST-COAST COULISSES

On the east of the Benom Coulisse, and separated from it by the Pahang River valley, is the Tahan Coulisse (12). On the Kelantan border this is marked by the highest mountain in the Peninsula, Gunong Tahan (7,186 feet) It is of quartzite and altered shaley rocks which are continued southwards as a well-marked belt, rising, however, to no great altitude. South

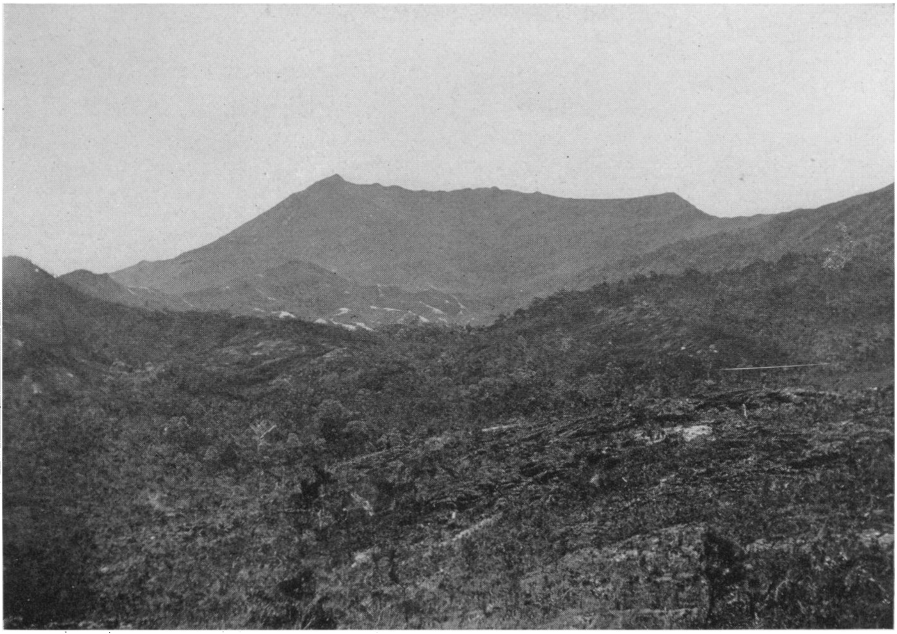

FIG. 6

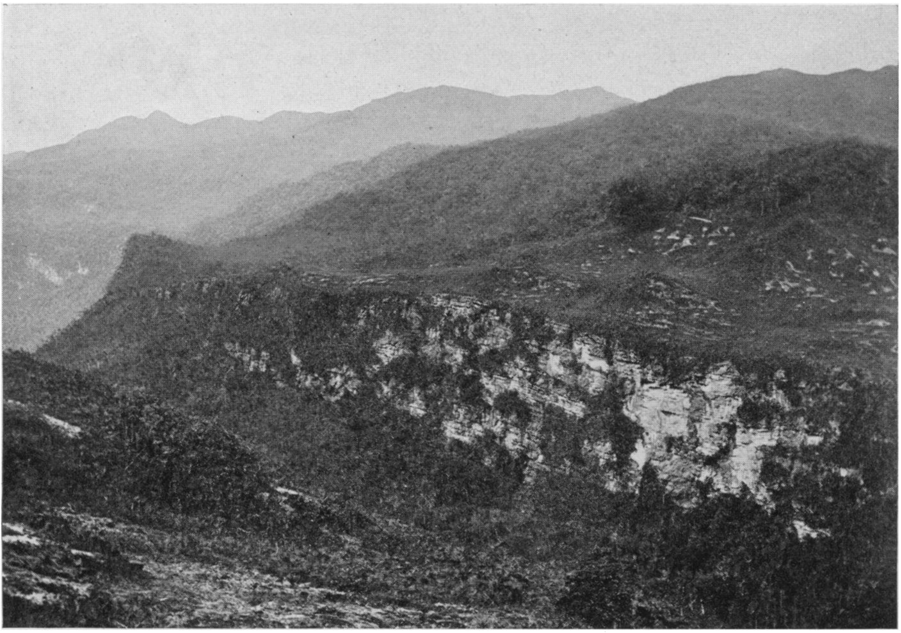

FIG. 7

FIG. 6—Gunong Tahan (7,188 feet) from an altitude of about 5,000 feet. (Photograph by C. Boden Kloss.)

FIG. 7—Cliffs near Gunong Tahan. This and Figure 6 show the open nature of the country here at an altitude of about 5,000 feet. A poor soil and the northeast monsoon have checked the growth of the usual luxuriant vegetation. (Photograph by C. Boden Kloss.)

of the Pahang River little is known about this belt, but granite and quartzite extending into Singapore Island appear to mark an extension of the coulisse (13).

To the east of the Tahan Coulisse again is one still more indefinite in its southern portion. This (14), the East-Coast Coulisse, is known in the north as a broad tract containing high mountains, believed to be mainly of granite. Detached granite and perhaps quartzite hills in South Pahang and Johore (15 and 16) mark its probable extension. This coulisse contains several areas of tin-bearing granite, and it is a reasonable conjecture that here denudation has laid bare the highest portion of a long tin-bearing granite ridge similar to the granite of the Main Range. Both 12 and 14 extend northwards farther than is indicated on the map, but I have no first-hand knowledge of them beyond the points marked. On the River Tekai quartzite hills, which are regarded as part of the Tahan Coulisse, are a well-marked feature; and in the headwaters of the Tembeling River the country between the Tahan and East-Coast Coulisses is also hilly.

Harmonious Structure of the Archipelago and Mainland

The Benom Coulisse is well marked between the Semantan and Jelai in Pahang, and the Kerbau and Bintang Coulisses to the west are well marked over almost the whole of their course; but the same cannot be claimed for the Tahan and East-Coast Coulisses. When we turn to the Archipelago, however, we find strong support for the courses indicated. In his recent paper Mr. Van Es, working, I believe, without any knowledge of the details of Peninsular geography, traced on a map of the western part of the Netherlands Indies the coulisses revealed by the study of its natural features. These are reproduced on a small scale in Figure 3, on which I have also indicated the Peninsular coulisses. Thus a coulisse in the islands southeast of Singapore carries on the line suggested for the East-Coast Coulisse. Another, with a longer course, prolongs the line of the Tahan Coulisse. The coulisse passing through Singkep and the north of Banka, if produced, joins on to the Kerbau Coulisse, or Main Range. The Bintang Coulisse may, without violating the harmony of the general structure of this large area, be connected, through the Aroa Islands (see Fig. 1), where quartzite is known, to the great sweeping curve of the coulisse that Mr. Van Es marks as passing Siak, the south of Banka, Billiton, the center of Borneo and ending in North Borneo a little beyond the great granite mountain Kinabalu (13,698 feet). It will be noted that the curve suggested for this coulisse through the Straits of Malacca is harmonious with the curve of the Kerbau Coulisse. I doubt if two independent workers could have more striking confirmation of their ideas than that afforded by the manner in which the coulisses I believe to exist in the Peninsula join up with those Mr. Van Es believes to exist in the western part of the Archipelago.

GENERAL CHARACTER OF THE PENINSULA

These coulisses form the framework of the Peninsula: they mark the lines along which rocks have been folded, hardened, and altered by intrusive igneous masses. An observant traveler, however, will first notice a general feature of the geography, which is that the Peninsula is for the most part a low-lying tract of land from which mountain ranges and isolated hills rise abruptly. How low the general surface of the land is can be gathered from the fact that Raub, close to the Main Range and between the headwaters of the Semantan and Lipis Rivers, these being tributaries far up the Pahang River, is only 462 feet above sea level; Bentong, to the south of Raub, only 321 feet; and Grik, far up the Perak River, 380 feet.

He would notice, too, the extraordinary course of the Pahang River and one of its tributaries, the Tembeling. The latter rises in the East-Coast Coulisse and flows to the west. It then turns south to join the Pahang which continues the southerly course for some way and then, turning sharply through more than a right angle, cuts through low quartzite hills of the Tahan Coulisse and flows eastward to the China Sea.

Moreover, if he were to follow up the Bera and Serting from this sharp bend in the Pahang, he would pass over very low country into Negri Sembilan; it is possible to convey a native boat without much difficulty from a tributary of the Serting overland into a tributary of the Muar and so reach the Straits of Malacca, the watershed between the Serting and Muar being inconspicuous. The actual height of the watershed is given by Mr. T. A. Kitching, of the Federated Malay States Survey Department, as 180 feet. A slight depression, therefore, in Negri Sembilan would divert the Pahang from its present course into the Straits of Malacca approximately along the present line of the Muar.

THE RIVERS

It is on the rivers that one can best enjoy the beautiful scenery of the Peninsula. The two chief rivers, the Pahang and Perak, vie with each other in this respect. The Pahang is perhaps the more beautiful in its lower reaches, broad and shallow, studded with sandy islands. The Perak excels in its upper reaches, flanked by virgin jungle, full of rapids, narrow, and tumultuous. The Pahang is navigable far above Kuala Lipis; but in the Tembeling and the headwaters of other tributaries there are bad rapids.

Owing to the steep rise of the mountains from the lower land the profiles of the rivers flowing down from them form sharp curves. In the hills the grade is of course steep, and there is little opportunity of depositing the load of detritus. On reaching the foot of the hills, however, the grade suddenly decreases, and detritus is deposited to form alluvial flats.

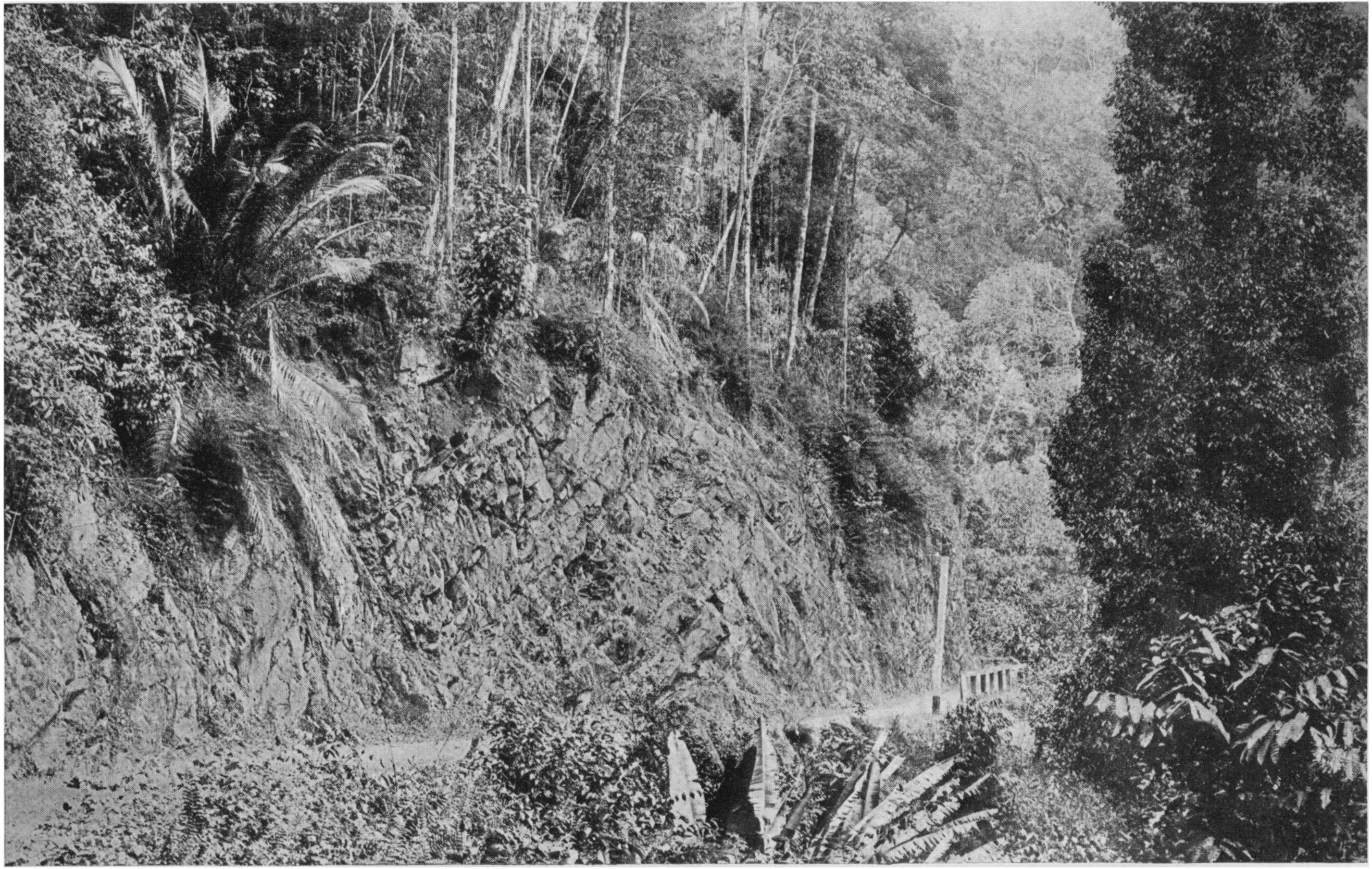

Fig. 8—The luxuriant Malayan vegetation. A road through quartzite hills in Pahang.

THE GRANITE HILLS

There are three distinct types of hills: granite, quartzite, and limestone. The granite hills are not confined to the coulisses shown on the map. Thus between 6 and 7 there are granite hills; and also between 7 and 9, to the east of Grik. There is evidence that in Kedah and the north of Perak the main mass of granite to which the granite coulisses are connected comes very close to the surface and that the covering of bedded rocks is consequently thin. The main mass of granite seems to lie deeper, however, east of the Kerbau Coulisse: I have suggested above that the East-Coast Coulisse may mark the summits of a granite ridge like the Kerbau Coulisse, but only just laid bare by denudation.

In Selangor there are two isolated granite hills that are now familiar landmarks: one, with an old Dutch fort crowning it, at Kuala Selangor; the other at Jugra, Parcellar Hill. It is perhaps worth noting that if the line of the Kledang Coulisse (8) is produced so as to curve in the same way as the Kerbau Coulisse (9), it will pass near these two hills.

The depth to which the granite weathers to a soft sandy clay and possibly other causes lead to the outlines of the granite hills being, for the most part, smoothly curved: precipices are rare, and even at altitudes over 6,000 feet the vegetation is luxuriant, so much so that one rarely obtains an extended view without felling trees. Most of the high granite peaks (the actual summit of Kerbau, I should mention, is formed of sedimentary rocks, not granite) have been cleared at one time or another for surveying purposes and have become covered again with a growth of secondary jungle, which is much worse to penetrate than virgin jungle and quite impossible to see through.

A noteworthy feature of the granite hills is the manner in which parts of the rock resist weathering and form "core boulders" that have the appearance of being waterworn. They are sometimes of great size, large enough to allow men to camp under a projecting side.

QUARTZITE HILLS

The quartzite mountains that I have ascended are Tahan, 7,186 feet; Kendrong (close to Grik), 4,010 feet; Kedah Peak, 3,978 feet; and Bongko, a little east of Benom in Pahang, 2,860 feet. Although the vegetation makes the ascent of any mountain here an easy matter compared with what it would be were there no tree trunks, branches, and roots to pull oneself up by, I know from experience that the quartzite mountains are less easy to ascend than the granite. Bedding and jointing in the rock make precipices of frequent occurrence. On the summit of Kedah Peak there is one that must be over a thousand feet high. Below the summit of Tahan the Tiku River flows through a precipitous gorge that might be called a canyon. Kendrong, which rises from country only about 500 feet high, is steeper than anything else I have climbed and would, I think, be impossible to all but practiced mountaineers, were it not for the vegetation.

In the northwestern corner of Langkawi Island there is a long junction between granite and quartzite. The latter has withstood weathering better than the granite and now forms a long serrated ridge with peaks over 2,000 feet high and precipices facing towards the granite, which does not rise to the same height.

Limestone Hills

Limestone hills occur in the Langkawi Islands, Perlis, Kedah, Perak, Selangor, Pahang, and I have seen some in Kelantan from the Pahang border. There are none in Negri Sembilan or Malacca; concerning Trengganu and Johore in this respect I have no information. On the mainland they are best developed in Perlis and the Kinta District of Perak. In Kinta they cover a considerable acreage; but both there and in other parts one finds isolated hills rising sharply from the surrounding country, often bounded by vertical or even overhanging cliffs.

When traveling by train through Perak one obtains a good view of the Kinta limestone hills and also of Gunong Pondok, an isolated hill between Kuala Kangsar and Taiping. This hill is 1,860 feet; in Kinta, Nasi Sehabat is 2,005 feet. Sinyum, one of the isolated hills in Pahang not far from Temerloh on the Pahang River, is 1,595 feet.

The boundary range between Perlis and Setul, as already mentioned, is limestone.

In the Langkawi Islands white limestone cliffs and islets of limestone with perpendicular sides undercut by the sea, rise out of the water just as they rise from low ground on the mainland. Were Perlis and the Kinta District flooded by an invasion of the sea the type of scenery would be identical with that of the Langkawi Islands.

As would be expected in this warm and rainy country, the limestone hills are honeycombed with caves, some of great size and beauty. Enclosed hollows shut in by high cliffs also occur. In Perlis such a hollow is known as a "wang." One of them, Wang Tangga (the Ladder Wang—so called because it is entered by a steep climb up steps on one side of a limestone cliff and an equally steep descent on the other), is large enough to contain a Malay village with paddy fields. Some of the caves in Perlis and Kinta contain payable deposits of tin ore. In Selangor one long, dark cave contains a very interesting but uncanny fauna, including large toads, spiders, and white snakes. The last are said to be harmless and only a bleached variety of a common non-venomous snake; but a friend of mine who was bitten by one was laid up for a fortnight with blood poisoning.

Evidence of a Marked Subsidence

The above description of the main features of the Peninsula is very brief and, I fear, unsatisfactory, because necessarily incomplete. There are enough data, however, to justify our inquiring if any connection can be traced between the present-day features and the succession of earth movements detailed earlier in this paper.

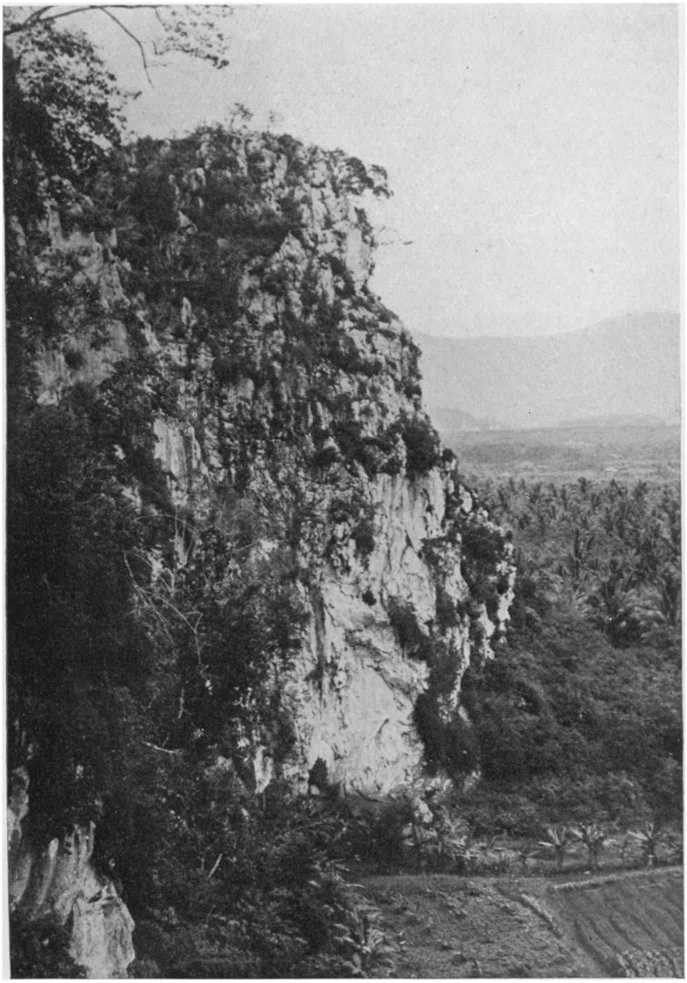

FIG. 9—A limestone cliff in the Kinta District. The distant range is the Kledang Coulisse with limestone hills at its foot.

In the first place, are the existing rivers responsible for the contrast of low-lying land and high ranges and isolated hills rising abruptly from it? To take a particular case, if this is so, then the Kinta River, an insignificant stream, has carved out a huge trough to within 300 feet of sea level between the Kledang Coulisse (Kledang 2,846 feet) and the Kerbau Coulisse (Kerbau 7,160 feet). This I cannot regard as likely. It is perhaps impossible to prove anything, but I will suggest what the course of events may have been.

The high ranges show evidence of great denudation; and, if we assume that that denudation began when the Archipelago was joined to the mainland and the whole surface was higher than it is now, we have a sufficient time interval in which the denudation could be effected. In other words, these ranges and hills are not modern features of a peninsula, but relics of the time when the Archipelago and the Peninsula were one and the river system was more powerful than now. On that mainland the present site of the Peninsula would be a wild mountainous tract, higher than now, where the river system began the work of carving out the hollows between the coulisses.

But when the subsidence set in marine denudation came into play and at the extreme limit of this movement, i. e. when the Peninsula itself was separated as a group of islands from the mainland of Asia, would have planed down a large part of the valleys formed by the old continental rivers. A depression of 500 feet below the present sea level would cover a very large part of the existing land. Grik would be under the sea; the part of the Kledang Coulisse between the Plus and Telok Anson would be an island. The Pahang River valley, Raub, and Bentong would be submerged. The granite, quartzite, and limestone hills would form a multitude of islands and islets. The biological evidence is strong enough for us to assume some such marked subsidence took place.

Results of Marine Denudation

When the elevatory movement that was to restore the Peninsula set in again, the old continental valleys would have been to a large extent modified by marine denudation, and the new drainage system would flow over the remnants of the continental ranges, such parts of the continental valleys as had not been submerged, and a plain of marine denudation. The remnants of the continental ranges have been described. The headwaters of the Perak River above Grik, the upper reaches of the Jelai above Kuala Lipis, and the headwaters of the Tembeling may represent unsubmerged portions of old valleys, but unfortunately we do not know and cannot expect to know exactly how far submergence went. The plain of marine denudation may, I think, be recognized in Perlis and the low watershed between Perlis and Siam, in the lowlands of Kedah, dotted with little hills, in the watershed between the Plus and Kinta Rivers and the low country on either side of it between the Kledang and Kerbau Coulisses, and in much of South Perak, Selangor, and Pahang. In the last state I would emphasize one locality, the Pahang-Kelantan watershed immediately to the west of the Tahan Coulisse (8). This watershed is also the state boundary; but because it is so low and indefinite the boundary has not yet been accurately fixed. I have been to the place and have had good views of both sides of the watershed from Gunong Tahan and from a limestone hill close to the boundary. It has been selected as the route for a new railway now under construction into Kelantan, and the Chief Resident Engineer for Construction of the Federated Malay States Railways informs me that the height of the railway on the boundary will be 628 feet. It is curious that this point, halfway across the broadest part of the Peninsula, should be so low and so close to Tahan, the highest mountain (7,186 feet); but if we admit the possibilities of marine denudation, it can be understood.

There are two factors that may have made the present drainage depart from the lines of the old continental drainage; one, the formation of new ridges by the irregularities of marine denudation; the other, the breaching of the island ranges by the same agency. On the west of the Main Range (6) a combination of both may account for the present courses of the Plus and Kinta Rivers. Let us suppose that in the continental stage, when the Archipelago was united to the mainland, there was no gap in the Kledang Coulisse through which the Plus could flow and that the Plus flowed south between 5 and 6, joining the Kinta. When the sea advanced up the Perak valley it may have broken through the Kledang Range on the site of the present Plus River and eroded the land on the other side towards the site of Sungei Siput. At the same time the sea would have advanced from the south between the Kledang and Kerbau Coulisses. Ultimately the two arms of the sea would meet making the southern part of the Kledang Coulisse an island. Then, when the sea retreated again, the Plus would flow through the breach made by the sea to join the Perak, and a low watershed would be left between the Plus and the Kinta.

Explanation of the Course of the Tembeling and Pahang Rivers

The course of the Tembeling and Pahang Rivers has been noted, and the following suggestions are now made to explain it. In the continental stage the Pahang River flowed between the Benom and Tahan Coulisses and continued its course in a south-southeasterly direction over the present drainage of the Muar. When the sea advanced it broke through the Tahan Coulisse east of the site of Temerloh, giving a new channel for the Pahang when it retreated again, reversing part of its southern drainage (now the Bera and Serting), and leaving a low watershed between the Serting and Muar. Similarly marine denudation, which could not break down the mass of Gunong Tahan, may have broken down the coulisse to the south of Tahan sufficiently to allow the Tembeling to flow through it; but this part of Pahang requires more detailed study. Another possible explanation that I have put forward for the present course of the Pahang, is that a stream flowing east from the Tahan Coulisse cut its way back and captured the Pahang, thus diverting it to the China Sea. Unfortunately, however, no stronger evidence than the general lie of the land now can be cited as evidence in support of either explanation. The dense jungle hides old river terraces, if such exist, and we can only say that either event would account for the present course of the Pahang River and the low watershed (180 feet) to the south.

MARINE DEPOSITS AND RAISED BEACHES

It may be objected that, if this submergence of the Peninsula took place, marine deposits laid down during that period should be visible now. In this respect there is very little positive evidence. Although on the neighboring island of Sumatra late Tertiary rocks are well developed, on the Peninsula as defined in this paper only three small patches are known; one in Selangor with coal, plant, and land-shell remains; another near Kuala Kangsar with limestone underlying a coal seam; and another on the Perlis-Siam border. There is good evidence of their being Tertiary but no means of determining whether they were deposited in the period of uplift in Miocene times that led to the Malay Archipelago being united to the continent of Asia or in the subsequent period of subsidence. The limestone near Kuala Kangsar points to marine conditions, of which there is no evidence in the other two patches; and it may have been formed when the sea converted the southern part of the Kledang Coulisse into an island.

In Kinta, certain high-level gravels may possibly have been laid down before the period of subsidence; but, whether this was so or not, any Tertiary deposits must have been subjected to considerable denudation after the sea retreated.

Apart from the biological evidence in the Peninsula, however, we must remember that movements which affected the area of the present Archipelago can hardly have failed to affect the area of the present Peninsula, so close are they one to the other; and for the last period of movement, which seems to be in progress still, that is the uplift which restored the Peninsula, we have more satisfactory testimony. At several localities near the coast raised shell beaches are found. I have seen them at the foot of Elephant Hill (between Alor Star and the sea, in Kedah), near the mouth of the Perak River, and near the mouth of the Bernam River. Mr. Leonard Wray says, "In a search for shell mounds in Lower Perak some interesting facts bearing on the formation of the coast and the valley of the Perak river were brought to light. At Pasir Panjang, Laut, there are no less than seven lines of old beaches, and between each there is a piece of low-lying land now used as padi fields."[8] From Kuala Selangor one can see a line of high land now far removed from the sea that has the appearance of an old coast line; while on Langkawi Island large stretches of sea sand in the interior of the island show that there must have been an actual uplift and that the sedimentation of the rivers is not the only factor concerned in the growth of the land.

In Perlis I found marine mollusca in a cave eleven miles inland and nearly 300 feet above sea level. This I have cited elsewhere as evidence of uplift; but since doing so I have seen accumulations of shells in Langkawi that make me admit that, although these Perlis shells were buried in phosphate, they might have been taken to the cave by human beings.

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[8] *Perak Museum Notes*, Vol. 2, Part I, p. 71.

The raised beaches are only about 50 feet above sea level. Unfortunately calcareous matter dissolves so quickly that one cannot expect shell beaches at great elevations, so that their absence farther inland and higher above sea level does not mean they never existed.[9]

On the east coast certain inland ridges, locally named "permatang," are believed to be old shore lines.

The similarity between the existing islands off the west coast and isolated hills rising from the coastal plain strongly suggests that the latter were quite recently islands in the sea, and in this regard we must not altogether despise native tradition. The idea that an inland hill was originally a ship navigated here by a Malay certainly does not inspire much confidence as evidence; but a legend that men from Acheen once attacked from boats a place now about seven miles inland on the Perlis-Kedah border, commands some respect.

There is no question that parts of the west coast are extending seawards today, e. g. the land at the mouth of the Kedah River; but, taking that case alone, deposition of sediment brought down by the river might account for the growth. The raised beaches, however, show that there has been an uplift as well.

SIMILARITY OF ISLANDS AND HILLS

A journey by sea from Penang to the Langkawi Islands gives a strong impression of the close similarity of the islands and hills on the mainland. Penang is separated from Province Wellesley by a shallow strait. A slight elevation would make of Penang Island a hill much like Kedah Peak, clearly visible beyond the harbor. As one approaches the Langkawis, having passed several islets which have their counterparts rising from the Kedah paddy fields, the isolated limestone hills of northern Kedah and Perlis are seen rising from a flat, low plain, just as some of the Langkawi islets ahead of the ship rise from the sea.

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[9] Mr. Boden Kloss informs me that he has seen old beaches at greater elevations than 50 feet.